

SHIP PRODUCTION COMMITTEE  
FACILITIES AND ENVIRONMENTAL EFFECTS  
SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
EDUCATION AND TRAINING

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# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **REAPS 5th Annual Technical Symposium Proceedings**

### **Paper No. 14: Steel Handling at NASSCO**

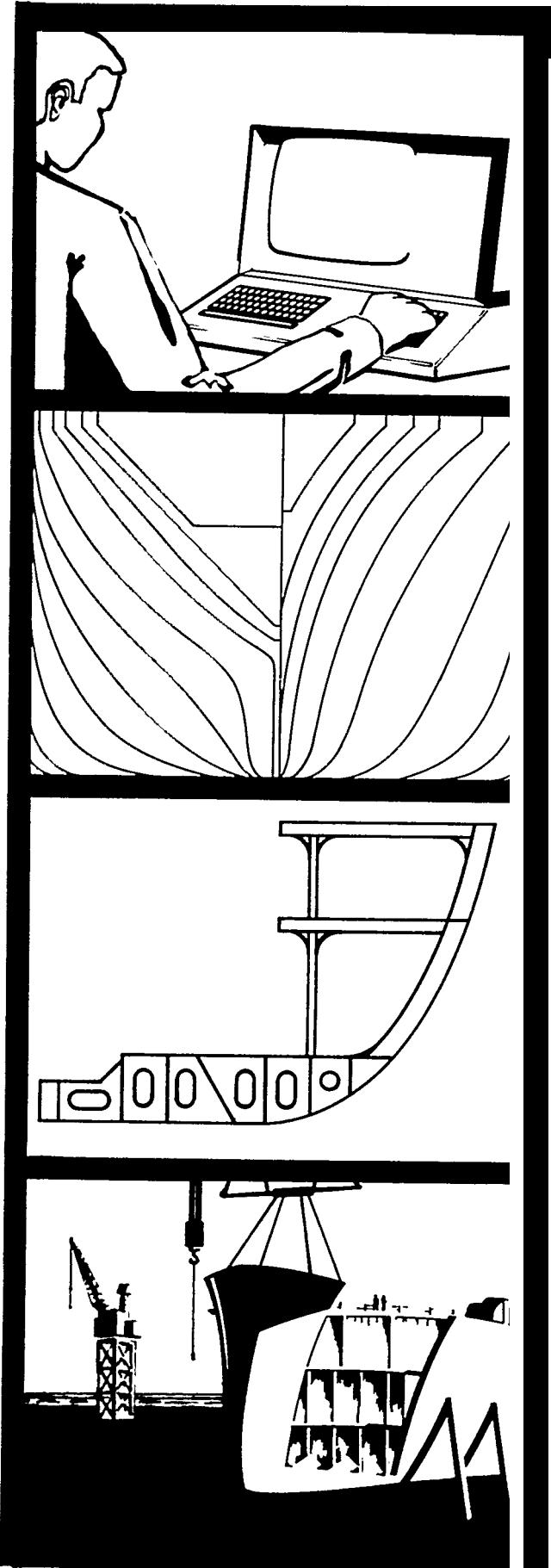
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CARDEROCK DIVISION,  
NAVAL SURFACE WARFARE CENTER

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## STEEL HANDLING AT NATIONAL STEEL AND SHIPBUILDING COMPANY

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## STEEL HANDLING AT NASSCO

### The Problem

Managers in manufacturing or fabrication work know that material handling is expensive and most of them complain about it. Even though in some applications, estimates reach as high as 50, 60 and 70 percent, those managers who complain most bitterly may not know just how expensive it is because the reference is usually only to those costs directly attributable to the handling itself; that is, wages for material handlers, perhaps wages for expeditors and the costs of storage and handling equipment and rolling stock. Not taken into account is the cost of a production crew which may be waiting for material or waiting for crane service or waiting for work space or spending time doing the same machine set-up two times for partial batches, and so on and so on. If these people are Shipfitters, Welders and Burners, they do not charge their time to material handling, they charge to shipfitting, welding and burning. No work has been accomplished but the meter is running. As a secondary consideration, a lot of people are getting frustrated and that probably also adds to costs.

### The Attack

National Steel and Shipbuilding Company completed major programs of expansion and modernization in 1968 and 1975. Having entered into major oceangoing ship construction in 1958, it is now the largest ship construction facility in the Western United States. Objectives of these programs were:

1. Increase working real estate.
2. Maximize output from a plant which would still have severe space restrictions.

3. Minimize production costs through effective work area arrangement and installation of an automated steel handling system.

In 1958, NASSCO's land area was less than 40 acres. In 1968 it was expanded to 60 acres. At present, we operate on 72 acres of land with a total lease of 126 acres including water area. There are three building ways ( 96 X 675 , 115 X 905 , and 115 X 906 ) and a building basin (1,000' X 176') which can accommodate a tanker design of approximately 200,000 deadweight tons. In each of the modernizations, the rationale was to balance priorities and compromise as necessary to give full consideration to the following:

1. Determine best mix of modular assembly and pre-outfitting with panel-type construction.
2. Modernize and upgrade some existing facilities in place.
3. Improve work flow patterns and handling systems in steel fabrication and assembly.

#### Justifying Steel Handling Investment

The cost of our automated steel handling system at NASSCO was justified through assessment of both the direct and the indirect effects of material handling methods on total production cost. It was easily apparent that with more efficient physical movement of material and with effective administrative control of that physical movement, we could increase productivity through:

- Reduced direct material handling cost.
- Reduced idle time of production workers.

#### Steel Handling System

The area of modernization representing the greatest departure from traditional methods was the installation of an integrated, centrally controlled system for the

handling of shipbuilding steel from receipt of material through subassembly. A well-planned and centrally controlled handling system can achieve benefits similar to continuous process manufacturing. This both enables and demands a high order of production planning at the detail level. The objective of the detail planning and the rapid, mechanized handling is to increase product through-put per unit of time and unit of labor applied.

The conceptual strategy for the mechanized steel handling system was to achieve the desired capacity by moving steel rapidly, continuously, sequentially and along pre-selected lines.

Rapidly

Reduce time in transit, increase time in production.

Continuously

When material is moved, move it without intermediate stops and without re-handling.

Sequentially

Reduce shuffling and work station storage by providing for fabrication operations to be accomplished in reasonable sequence of geography and time.

Pre-selected Lines

Based on proper sequencing, arrange for material to be routed for automated transfer from work station to work station.

In converting concept to reality, the steel handling system was designed to best serve existing Plate Shop and Subassembly areas (Figures 1, 2, 3). This was an important distinction as opposed to building a complete new facility. In development of a system for our existing, working shipyard, goals were necessarily

tempered by the necessity to hold rearrangement of existing facilities to a reasonable minimum so as not to overly obstruct ongoing operations. The goal of improved material flow required incorporation of new equipment and existing equipment into an arrangement approaching optimum linear flow patterns. As you can imagine, the period of physical transition was most trying. However, we are quite satisfied that the result was worth the pain and suffering. Two important new prefabrication capabilities were added concurrent with installation of the steel handling system:

Flame Planer - edge preparation of plate and stripping of plate.

Beam Welder - fabrication of welded shapes from stripped plate.

#### Flow Pattern and Equipment

NASSCO's steel plate storage yard consists of approximately two acres of land, a 15 ton bridge gantry crane and a railroad spur (Figure 4). We can conveniently store approximately 40,000 tons of steel plates, and probably work with up to 100,000 tons, if necessary. We operate with about 300 separate piles of different size plates (many mixed). We average about 20 railroad cars and five truck loads of incoming steel per week for an average of 1,650 tons or about 800 plates per week. Our busiest week to date caused us to process 30 rail cars and 3,700 tons of plate.

The 15 ton bridge crane is a VIA NOVA installed in 1975. It has a rail span of 170' and a working beam of 230'. It can stack and unstack plate piles up to 12 feet.

The steel plates are received primarily by rail car. NASSCO justified installation of a new rail spur by showing a 30% saving of transportation cost over trucking plates. Our primary supplier is Kaiser Steel of Fontana (Los Angeles). The primary reason for still shipping some steel by truck is that immediacy of need sometimes coincides with a rail car shortage at the steel mill.

Once steel has been received, the standard operating procedure is for the Control Tower (staffed by Production Control personnel) to start the steel handling system with an order for a specific plate to be delivered, via a Wheelabrator, to a burning machine operation, an automated panel line, or directly to an assembly work station. The steel yard crane loads all plates and shapes to the Wheelabrator for peen blasting to remove mill scale prior to any fabrication operations. Since there is no back up to the single steel yard crane, we normally back-stack, or stage, the next 24 hours worth of plate ahead of the production operations in order to prevent production stoppage due to a breakdown of the crane. Limited in-process storage areas and dynamic production needs prevent us from staging even more material away from the steel yard.

As mentioned above, the first production work station for steel is the Wheelabrator. It provides a surface "peen" blast to remove mill scale, and can apply a primer coat of paint if the material is destined to go directly to erection. The Wheelabrator can blast at an average of ten lineal feet per minute and thus prepares a standard 10' by 38' plate in about four (4) minutes. At the present time this would be our restricting or bottleneck factor if we were to schedule more than an average of 2,000 tons of sub-assembled steel per week. This first production work station is built into the automated handling system, being fed and relieved by the conveyor system which carries forward to the other work stations.

The automatic conveyor system consists of four (4) elements:

1. Roller tables.
2. Beam tables.
3. Transfer cars (3).
4. Collocator system (VIA NOVA) including two collocator cars.

The prime mover of the conveyor system is the automatic collocator cars and their tracks (Figures 5, 6, 10, 11). The cars (2) run up to a speed of 100 Ft/minute on two different track systems, one of 800 feet, the other of 1,000 feet. The conveyor system can run in three different modes:

1. Central Automatic Control.
2. Local Automatic Control.
3. Local Manual Control.

The most frequent mode is Central Automatic Control, which is operated by a console operator in the Control Tower (not unlike a small airport control tower -- elevated, with a 360° view of all systems). The pre-planned automatic sequencing is carried out on mechanical instruction by the console operators. The operator simply enters instructions of where to move the material. The Collocator system automatically analyzes and reacts to the conditions of the system, such as:

1. Transfer car or table already loaded.
2. Magnetic crane beam in collocator track.
3. Slow speed at start up.
4. Delay at crossings.
5. Siren when car is in motion.

The cars do not have cables connected for their power, but use crane type conductors and collectors.

The overall system is designed to handle plates up to 10' x 39' long. It can handle a 41' plate in the manual mode. Due to the space limitations and alignment of the existing facilities, there are two rotating roller tables to load and transfer the plates, in addition to the three transfer cars that work on an axis perpendicular to the collocator system (Figures 5, 10). The transfer cars are used to load the various burning machines, panel line, or production areas.

As stated, the total conveyor system consists of the steel yard crane, Wheelabrator, and collocator cars with 1,800 feet of track. Assuming the system to be empty of work-in-process, we could replace a defective plate at a sub-assembly table in less than ten (10) minutes, even though it would travel nearly one-half mile and require two crane lifts, three transfer car moves, and two collocator car trips.

The conveyor system routinely feeds two production tables, a panel line and seven (7) burning machines. The burning machines at NASSCO are:

1. CM 150 N/C Plasma Shape Cutting Machine, which can cut plates at 100" per minute, up to 1" thick. It cuts at a temperature of up to 40,000° on a shallow bed of water to reduce pollutants (Figure 7).
2. CM 100 Gas Stripping Machine.
3. CM 70 N/C Tape Driven Shape Cutting Machine.
4. (2) CM 60 Shape Cutting Machines.
5. CM 56 Shape Cutting Machine.
6. Flame Planer.

The conveyor system also directly feeds our Tee-Beam welder (Figure 9), and a plate roll for plates up to 40' wide, 2" thick.

#### Benefits To Handling From Standardization

Reduction in steel handling costs can be derived in other ways than simply employing better and faster handling systems. As an example of this, we at NASSCO examined our design and nesting practices relative to minimizing ship weight and minimizing generation of scrap steel. Commencing with a complete listing of plate sizes and their applications in ships about to be built, we did a study which showed that in exchange for acceptably small increases in

ship weight and steel scrap, we could significantly reduce the number of different stock numbers to be used -- and therefore to be stored. Considering our limited steel storage area, fewer stock numbers directly converted to fewer mixed piles. This, in turn, meant cost reduction through less multiple handling. It is worth mentioning that there were also beneficial effects for Engineering and Purchasing as well as for the Steel Mill.

The method used in the standardization exercise was to produce a computer listing of all stock plates for one ship of one class. The list was in order of grade, thickness, width and length and also showed plate weight and quantity required. Successive efforts at combining near-like plates were performed through eight iterations with each listing having a reduced number of plates from the one before. At that point a decision was made that further increase in ship weight would be unacceptable.

The result of the standardization effort was a reduction in stock numbers of approximately 50 percent and steel weight increase of about 3 percent. A tabulation of the successive cuts is shown below:

Run No.	Total Stk. No's	Reduction in Stk. No's	Total Wt. Plates (Lbs)	Increased Wt. (Lbs)	% Wt. Increase
0	847	0	29,497,311	14,880	0
1	747	100	29,563,676	66,365	.225
2	656	191	29,609,266	111,955	.38
3	609	238	29,644,510	147,199	.50
4	551	296	29,718,558	221,247	.75
5	508	339	29,802,423	305,112	1.03
6	445	402	29,969,840	472,529	1.60
7	420	427	29,993,135	495,824	1.68
8	362	485	30,458,759	961,448	3.26

Similar studies were done on other ship classes under contract and on shapes and bar stock. The overall reduction in stock numbers was on the order of one-third.

### Control Tower

The heart and nerve center of NASSCO's steel handling system is the Control Tower and the detail planning of manufacturing operations -- work station by work station. Within the Control Tower is the push-button console where the operator directs the system with electric signals and continuously monitors the system by means of a graphic status display (Figure 12).

The major portion of this system (collocator, transfer cars, Tower) was designed and built in 1968. In 1975 the yard acquired more land in order to move the steel yard to its present location and installed the steel yard crane and additional collocator run. Based upon data from SPARDIS (Scheduling, Planning and Reporting Data Information System), the "Tower" starts and directs all movement of raw steel (plates and shapes) into production. As dictated by schedules and daily, computer-generated priority lists, Production Control personnel manning the Tower routinely:

1. Order material to be delivered to production, via Wheelabrator.
2. Schedule, load/unload all burning machines.
3. Schedule, load/unload Tee-Bar welder.
4. Schedule, load/unload panel line.
5. Schedule and release all erection unit assemblies to the platens (based on master schedule and material availability).
6. Update/record all reported progress of burning machines and platens. This is done via teleprocessing terminals through an on-line computer system.
7. Provide feedback to the various planning groups pertaining to recommended or necessary "field" changes or material shortages.

In reality, the Tower and other Production Control personnel provide to platen supervision the proper schedule information and material availability status.

It is normally done by a two part, daily, computer-generated report called:

1. Laydown Work Scheduled in Priority Sequence.
2. Sub-Assembly Work Scheduled in Priority Sequence.

This report prioritizes and lists all assemblies either not yet started or in-process. The priority is dynamic and is based upon erection schedules. The priority can be changed on-line overnight by authorized Production Control personnel. We normally schedule sub-assembly completion approximately six weeks prior to erection need. This allows significant leeway by the platen supervision to best utilize their assets (manpower, table space, hardware). At any given time, we usually have 50 to 100 assemblies ready to start, listed in erection priority. All raw material and manufactured components must be available in inventories maintained and controlled by Production Control or at least be in-process prior to release of the erection unit to the Platen.

#### Related Facilities

The platens (or sub-assembly) consists of eight different tables with a total area of 123,500 square feet, or 2.8 acres of working area. The Platens, Shops, Erection and Outfitting areas are serviced by 49 different cranes. Some of these cranes were built as long ago as 1939, and represent 14 different manufacturers, which of course is a major challenge to the cross training of operators and maintenance support. Included are:

12 "Whirley" gantries (45 to 175 ton capacity).

6 Mobile Cranes

6 Magnet Cranes

### Panel Line

NASSCO's four station automated panel line was designed to assemble panels up to 40' by 65'. The movement of the steel plates and panels is accomplished by power driven friction wheels and continuous chains strategically located in the bed of roller chocks. Except for the turning over of panels, the alignment and movement of panels can be controlled by a single operator. An eight hour shift can produce five panels of six plates each. The limiting factor is welding time governed by plate thickness. The operating stations are:

#1 Tack Welding of Plates

#2 First Side Welding (Submerged Arc)

#3 Turn Over, Second Side Welding (Submerged Arc)

#4 Lay-Out of Panel

### Frame-Bender

In 1979 we expect to have our new "frame-bender" installed and operating. This N/C controlled innovating design is capable of cold shaping beams, with webs up to 25" deep by 42' long, within a tolerance of  $\pm 1/4"$  for total length.

### Conclusion

In constructing a San Diego Class tanker, the steel we handle can be represented roughly as follows:

30,000 tons made up of:

10,000 plates

5,000 shapes

2,000 miscellaneous items

1,000 erection assemblies made up of:

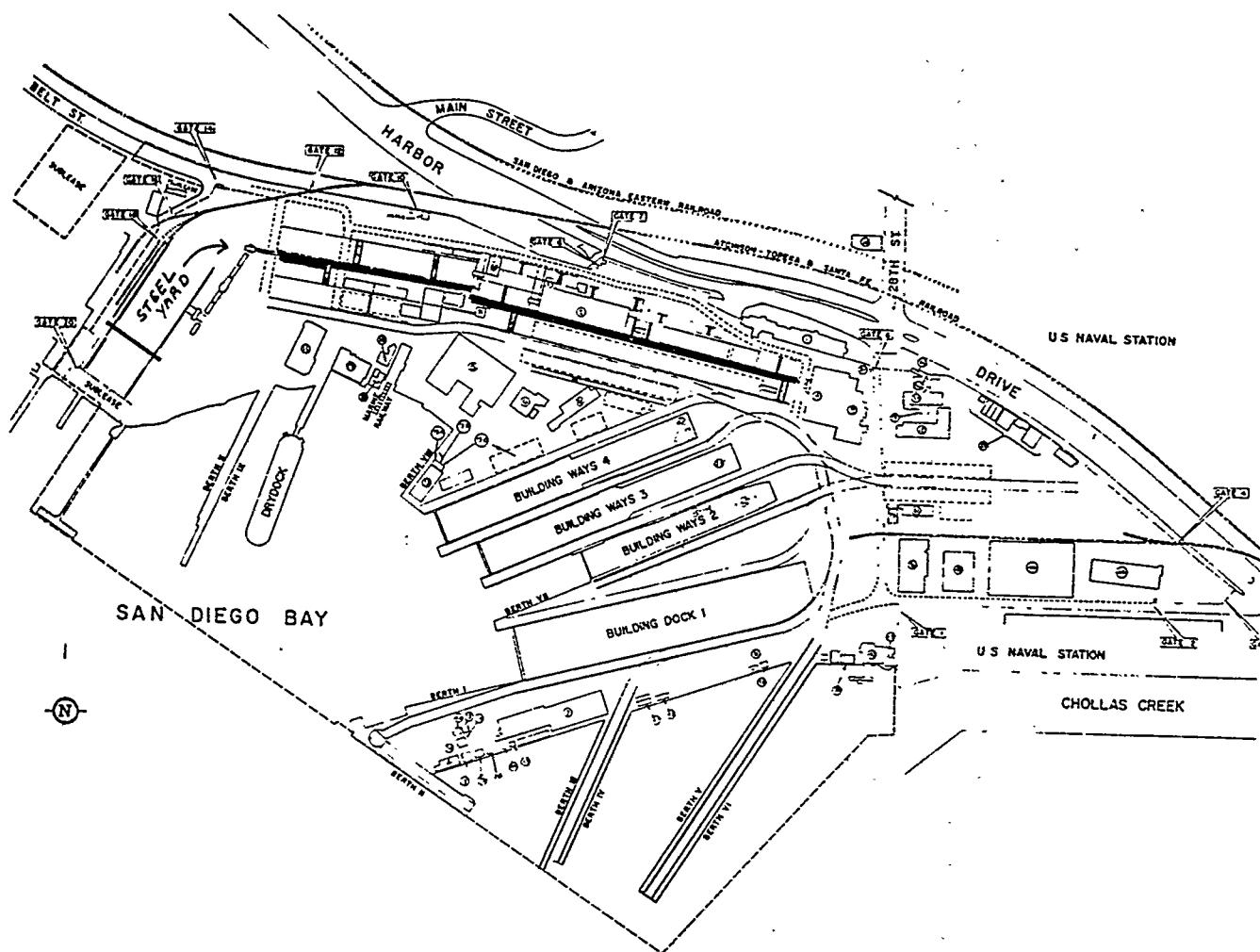
14,000 subassemblies

18,000 piece parts

750 tons of weld rod

The most satisfying move to most of us is when we handle it all in one piece.

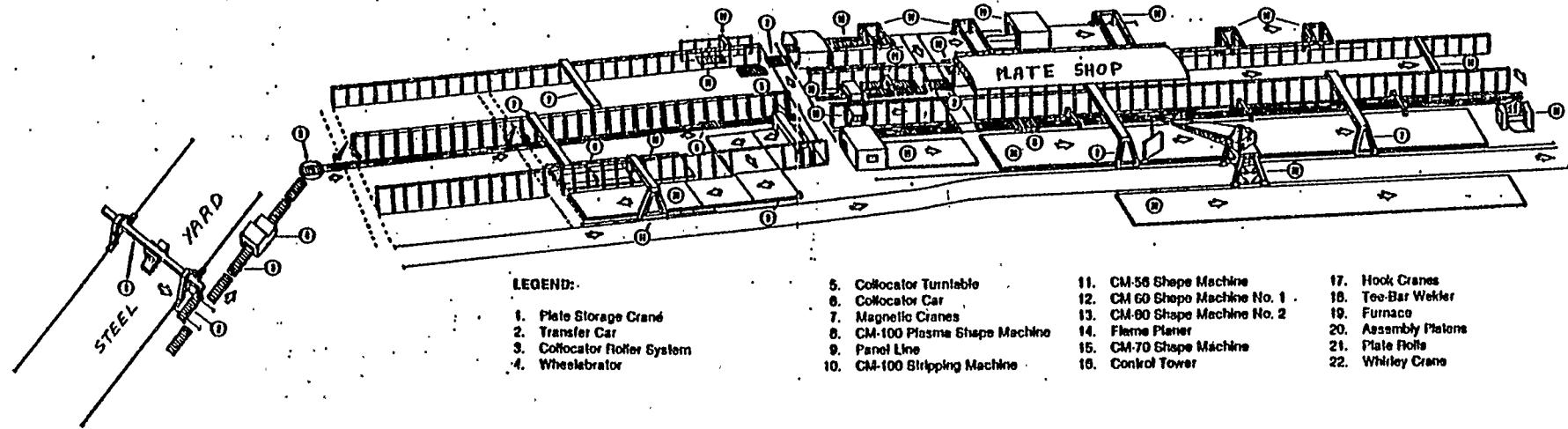
# YARD LAYOUT



## LEGEND

1 ADMINISTRATION	22 GRIT BLAST DIVISION	55 PATTERN SHOP
2 PLATE SHOP	23 WASHROOM WOMEN	56 SECURITY DEPT.
3 GALVANIZING	24 WASHROOM MEN	58 CONTROL TOWER
4 PIPE SHOP	26 TEMPLATE STORAGE	59 TEMPLATE STORAGE
6 ELECTRIC SHOP	27 MEN'S RESTROOM	60 TEMPLATE STORAGE
7 SHEET METAL SHOP	28 TOOLROOM, 28th ST.	61 LOCKER & SHOWER ROOM
8 MACHINE SHOP	29 CENTRAL TOOL ROOM	62 WELDING SCHOOL
9 FOUNDRY	30 CO <sub>2</sub> & ARGON GAS	66 PRODUCTION OFFICES
10 COMPRESSOR 2200 CFM	31 PAINT EQUIP OVERHAUL	68 COMPUTER SERVICES
11 STOREROOM	33 ELECTRONIC CLEANING	71 CM-70 CONTROL WAREHOUSE
12 MAINTENANCE	41 NASSCO STORE	72 FED-MART WAREHOUSE
13 MACHINIST BULL PEN	42 YARD CONFERENCE ROOM	73 BOILER WAREHOUSE
14 OUTFITTING OFFICE	43 WAREHOUSE	77 STEEL YARD CONTROL
15 STORAGE SHACK	44 WAREHOUSE	78 TRANSPORTATION OFFICE
17 PAINT DIVISION	45 WAREHOUSING DEPT.	79 N/C CARPENTER SHOP
18 BY WAYS REPAIR & LOCKERS	46 FIBERGLASS	80 GATE 14 SECURITY
19 CARPENTER SHOP	51 ENGINEERING	81 GATE 6 SECURITY
20 WELD REPAIR OFFICE	54 QUALITY ASSURANCE	

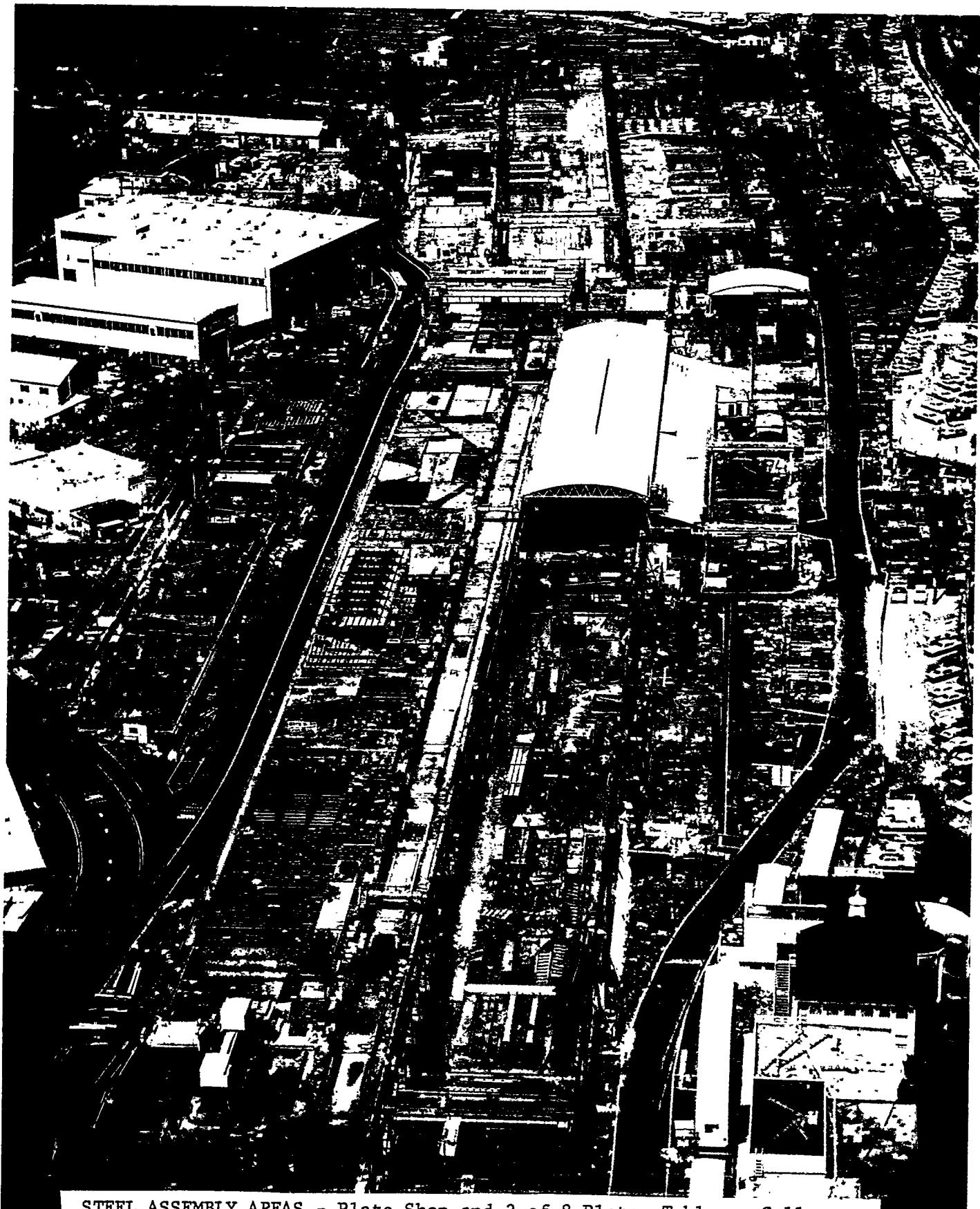
Figure 1

**BUILDING POSITIONS**

	DIMENSIONS		LOA	MAX SHIP SIZE	
	L	W		BEAM	DWT
No. 1 Building Dock	1000	176	980	170	200,000
No. 2 Inclined Ways	675	96	690	90	40,000
No. 3 Inclined Ways	906	115	900	106	90,000
No. 4 Inclined Ways	905	115	900	106	90,000

Figure 2

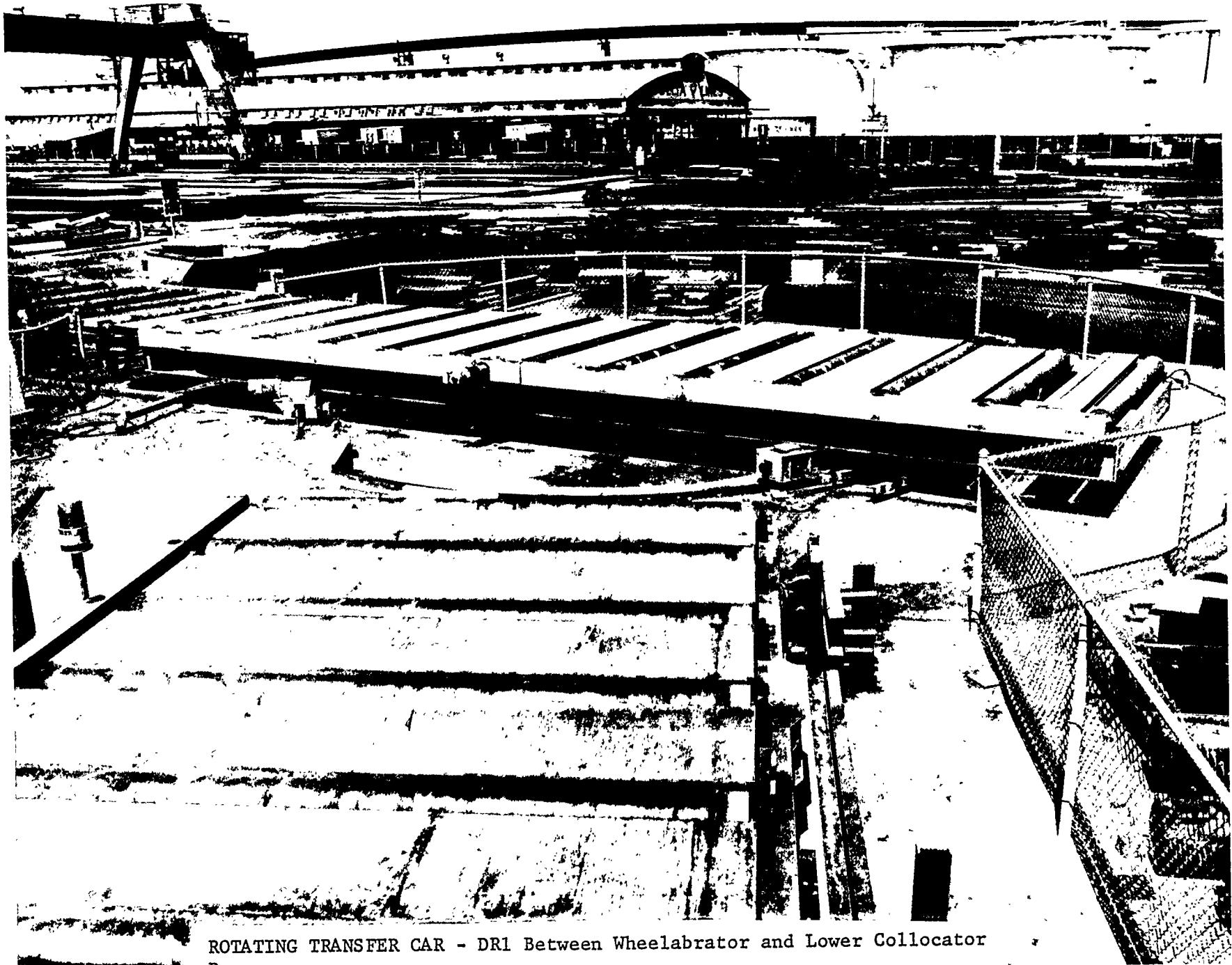
AUTOMATED STEEL HANDLING SYSTEM - Sketch of System as Installed in Existing Plate Shop, Platen Facilities.



STEEL ASSEMBLY AREAS - Plate Shop and 3 of 8 Platen Tables. Collocator Car System is Physical Divider Between Shop and Tables.

STEEL PLATE STORAGE AREA - "507" Crane Loading "T-1" Transfer Car to Feed Wheelabrator.

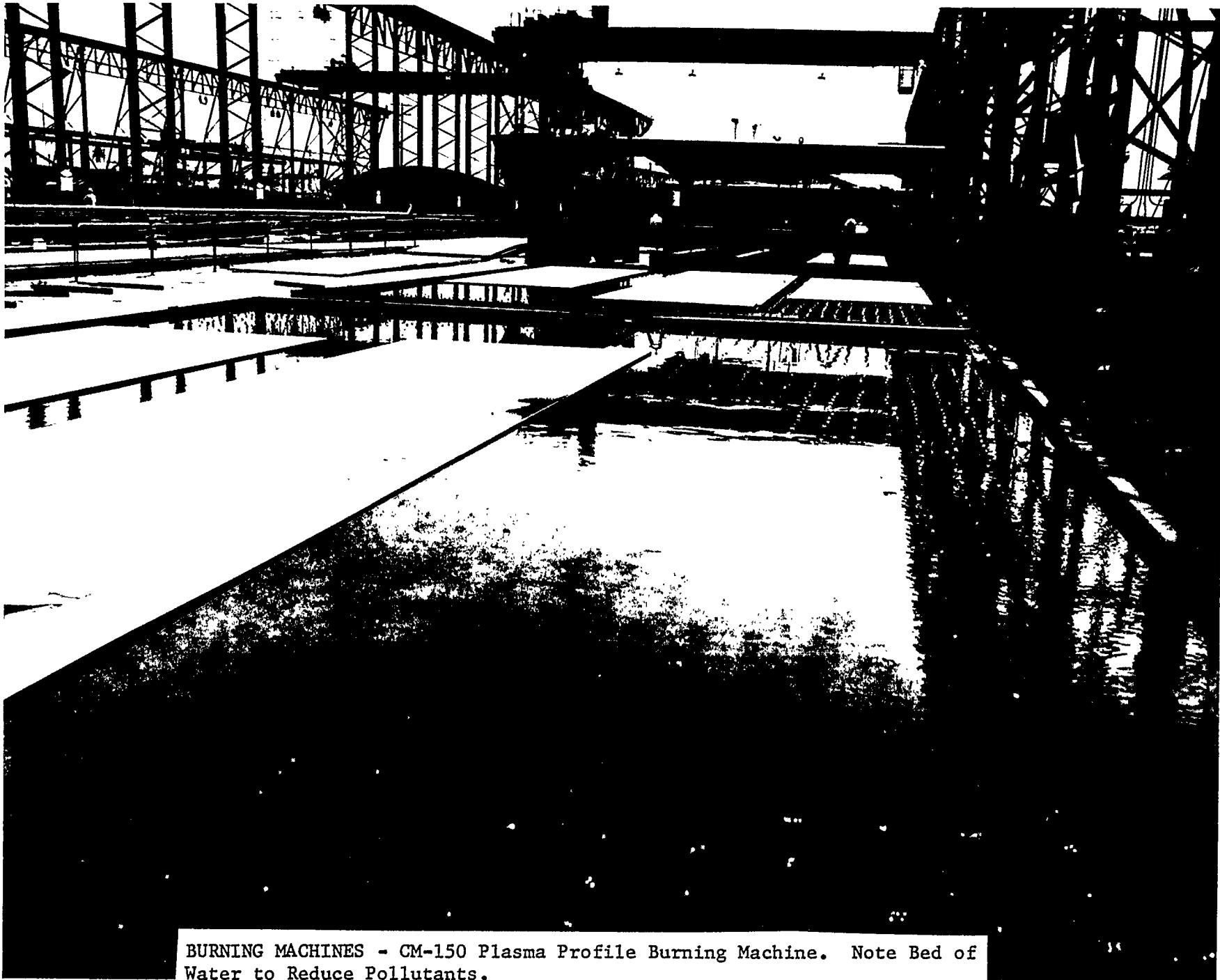




ROTATING TRANSFER CAR - DR1 Between Whealabrator and Lower Collocator Run.

COLLOCATOR RUN, LOWER - Storage Area and CM-150 and CM-100 to Right  
of Tracks.





BURNING MACHINES - CM-150 Plasma Profile Burning Machine. Note Bed of Water to Reduce Pollutants.

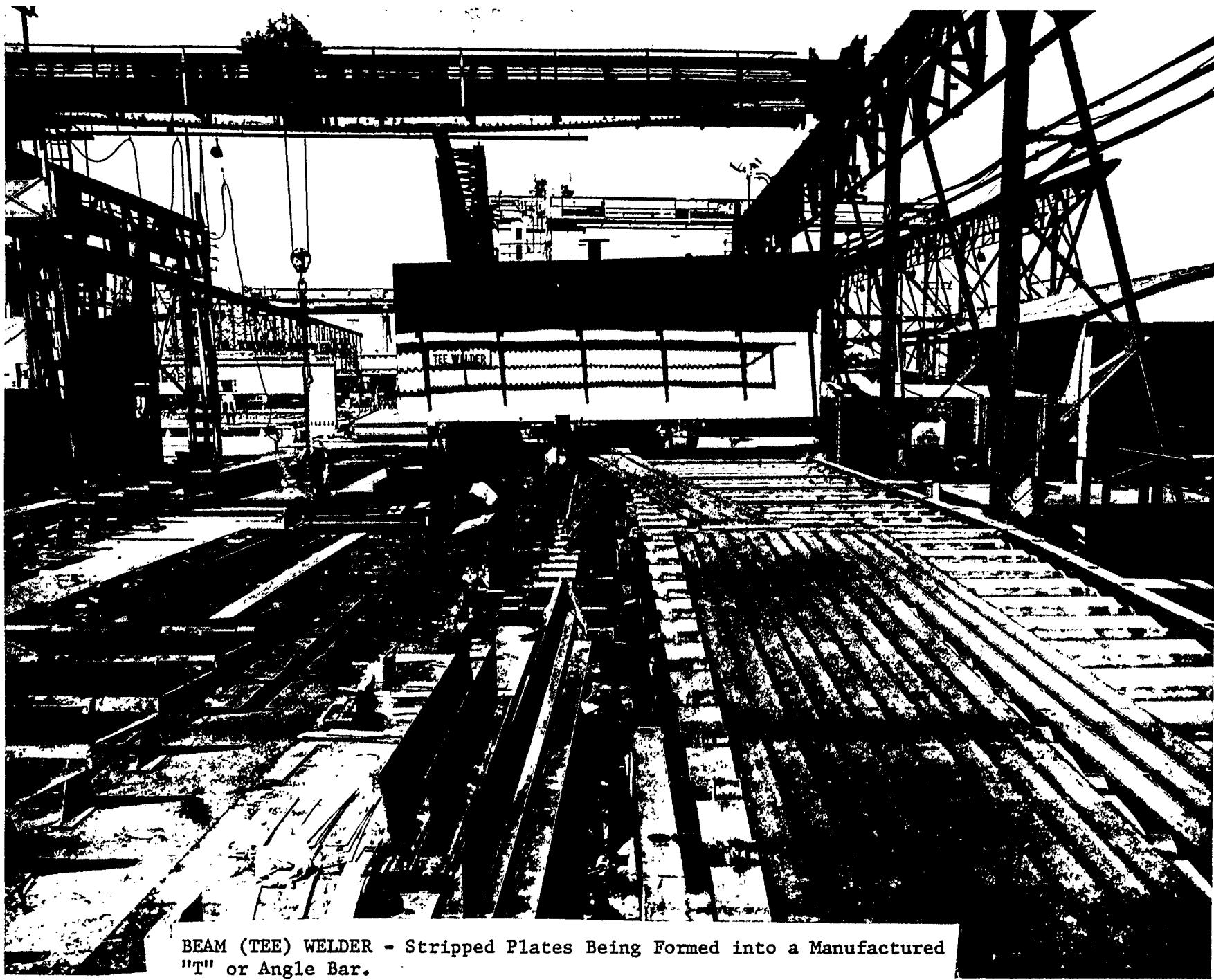
PANEL LINE - Stations No. 1 (Tack Welding) and No. 2 (1st Side Welding).



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Figure 8

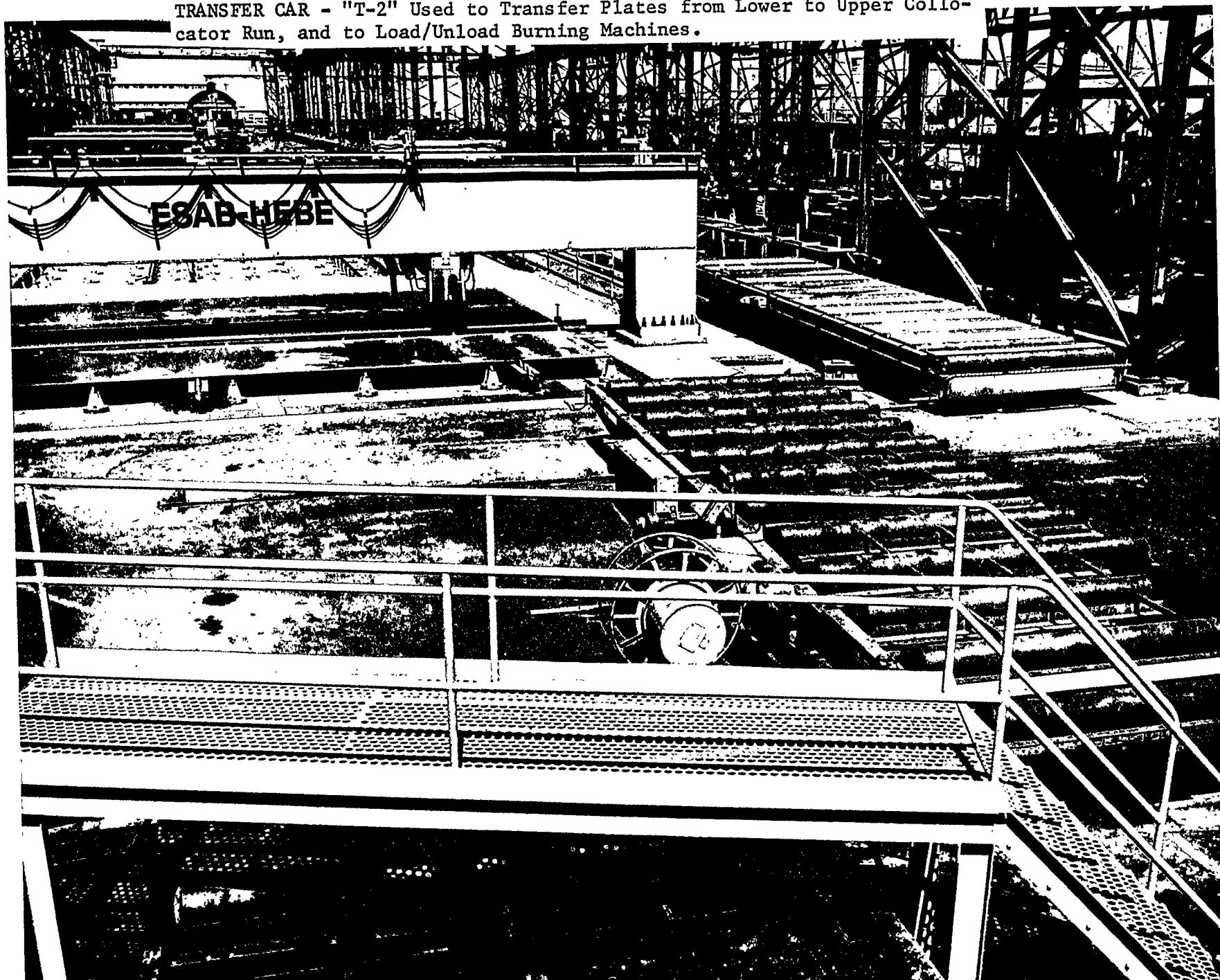
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BEAM (TEE) WELDER - Stripped Plates Being Formed into a Manufactured  
"T" or Angle Bar.

Figure 9

TRANSFER CAR - "T-2" Used to Transfer Plates from Lower to Upper Collo-  
cator Run, and to Load/Unload Burning Machines.



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COLLOCATOR RUN, UPPER - Collocator Car and Adjoining Platen Table;  
Magnetic Beam Crane in Far Background.

Figure 11

CENTRAL CONTROL CONSOLE - Located in Control Tower, Used to Order Steel Plate Movements and Show Graphic Display of Activity in Process.

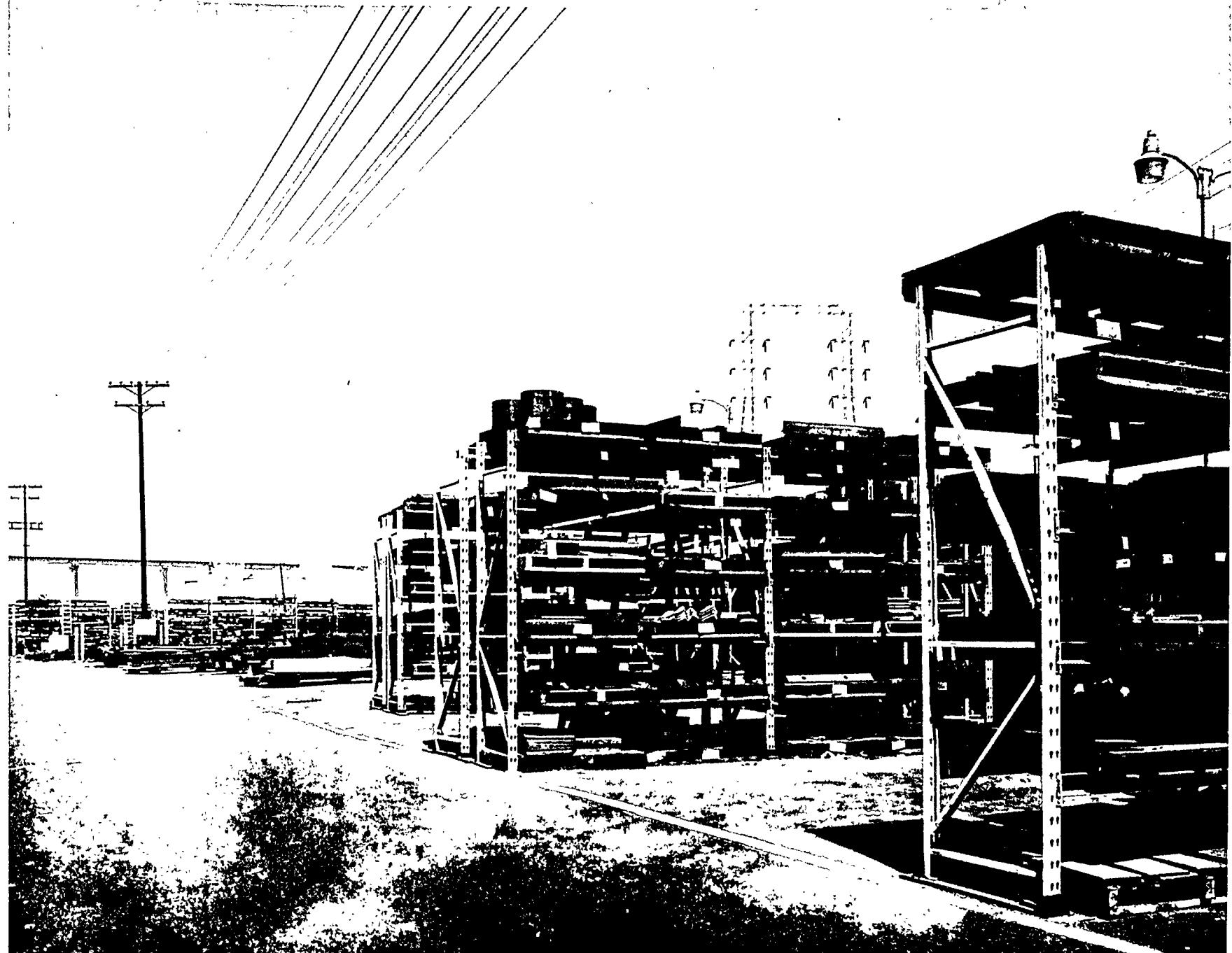


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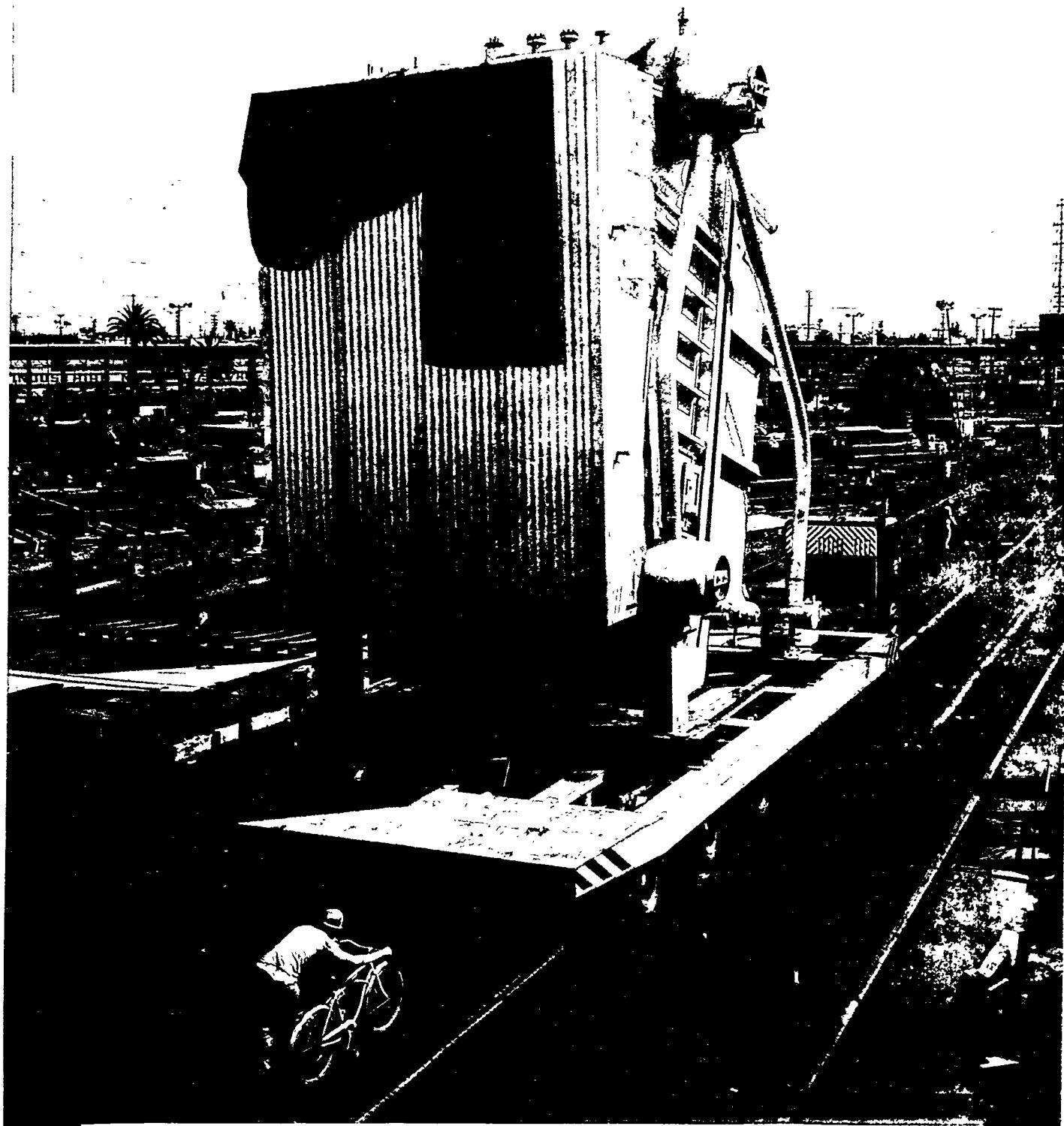
MAGNETIC BEAM CRANE - Used to Service Prefabrication Operation and Storage Area.

STORAGE RACKS - Work-in-Process Material Storage Racks and "Carrier"  
Load Storage of Tee Beams and Angles.





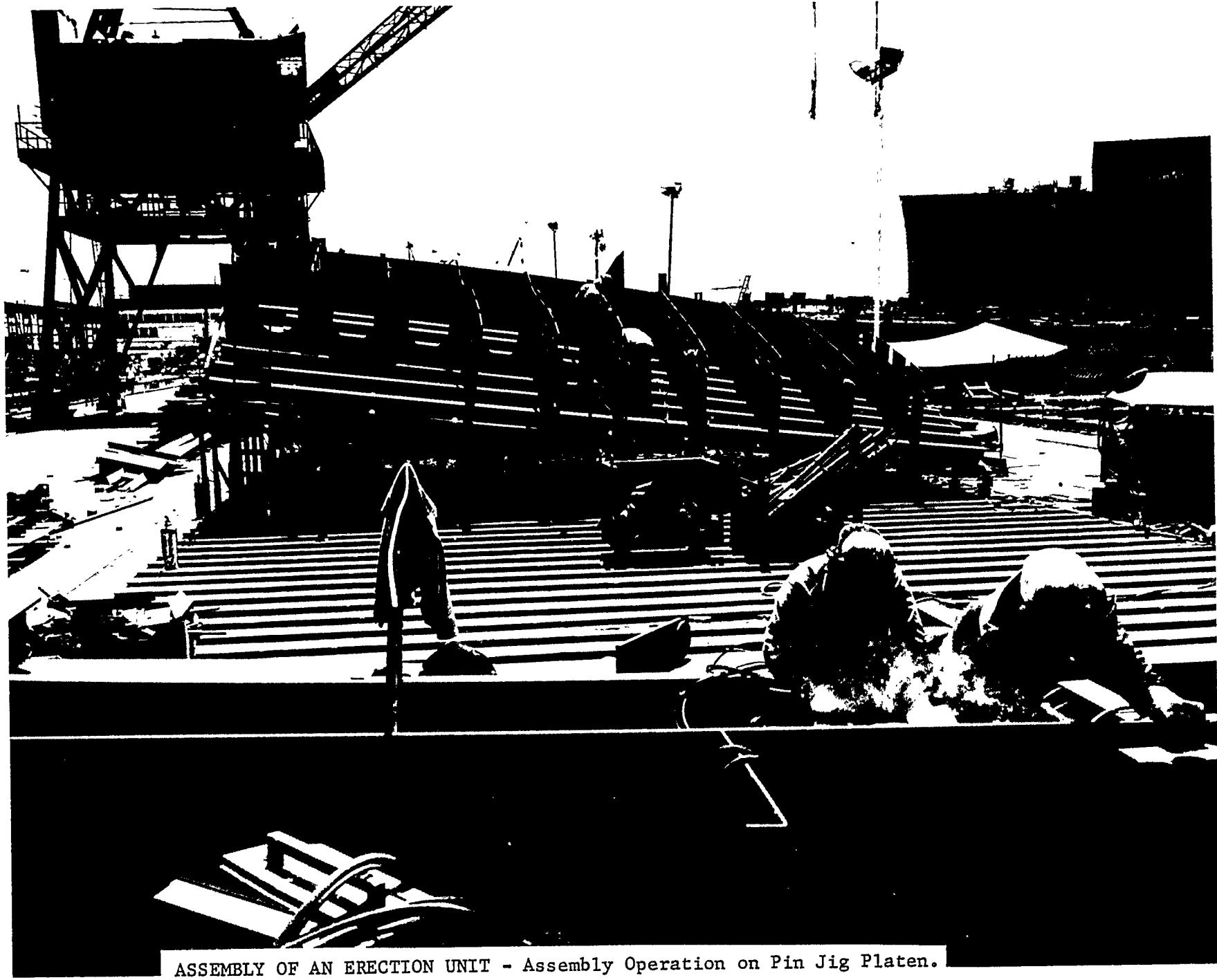
HANDLING EQUIPMENT - "Carriers" Used to Transport Bundles of Beams,  
Angles or Other Long Shapes.

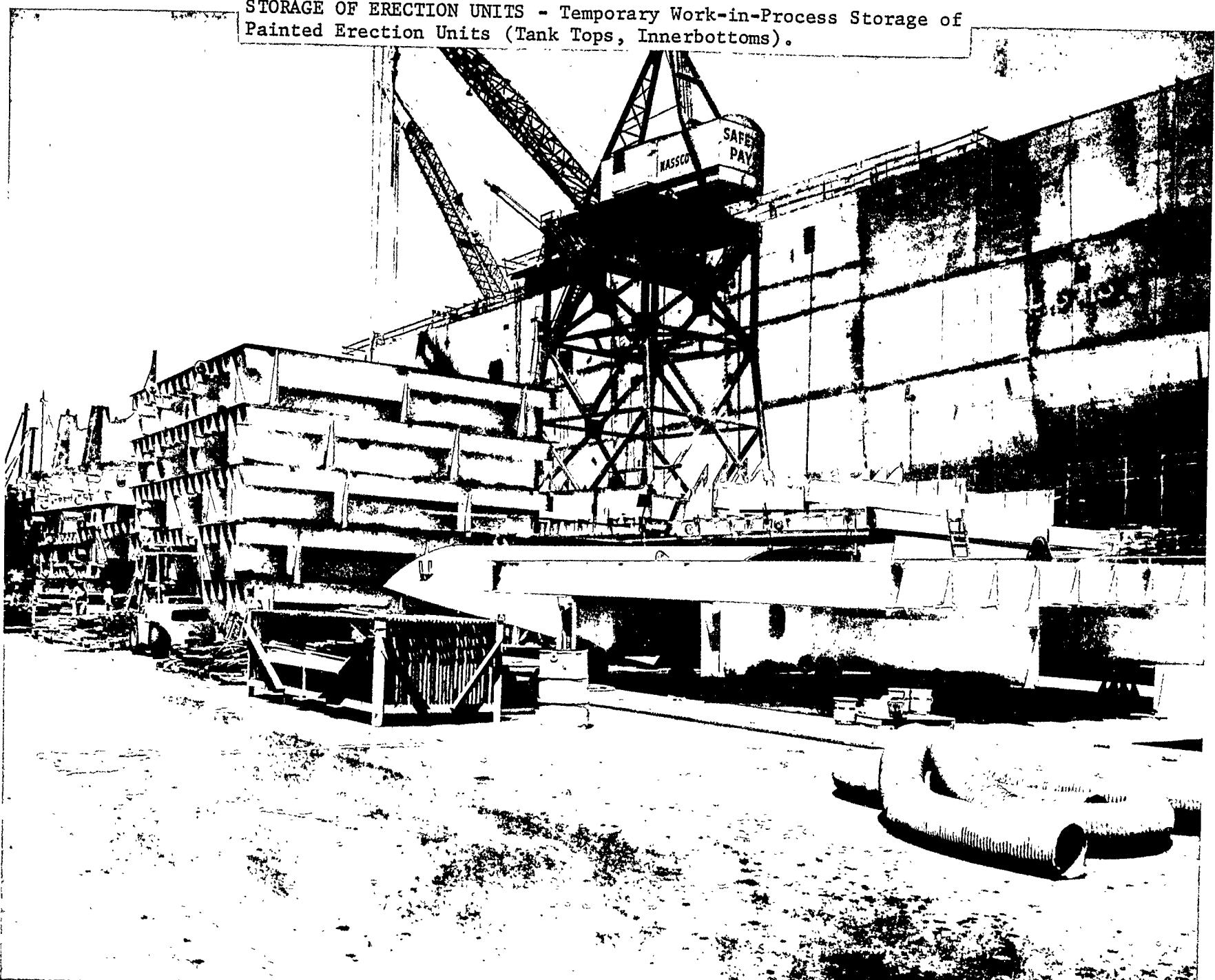


HANDLING EQUIPMENT - "Big Bertha" Trailer (Capacity of 130 Tons), Transporting a "San Diego" Class Boiler Assembled at NASSCO.

Figure 17

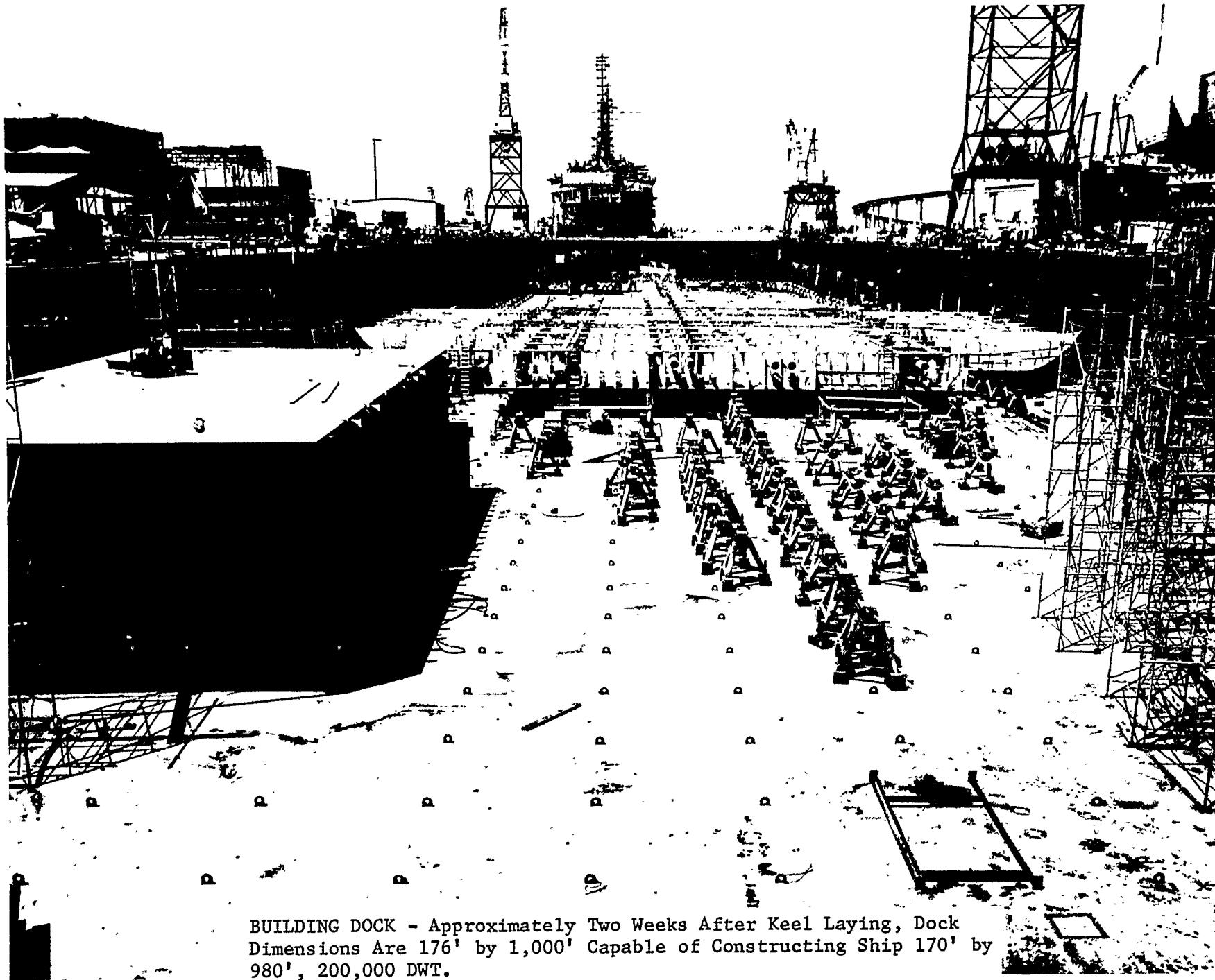
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Figure 18



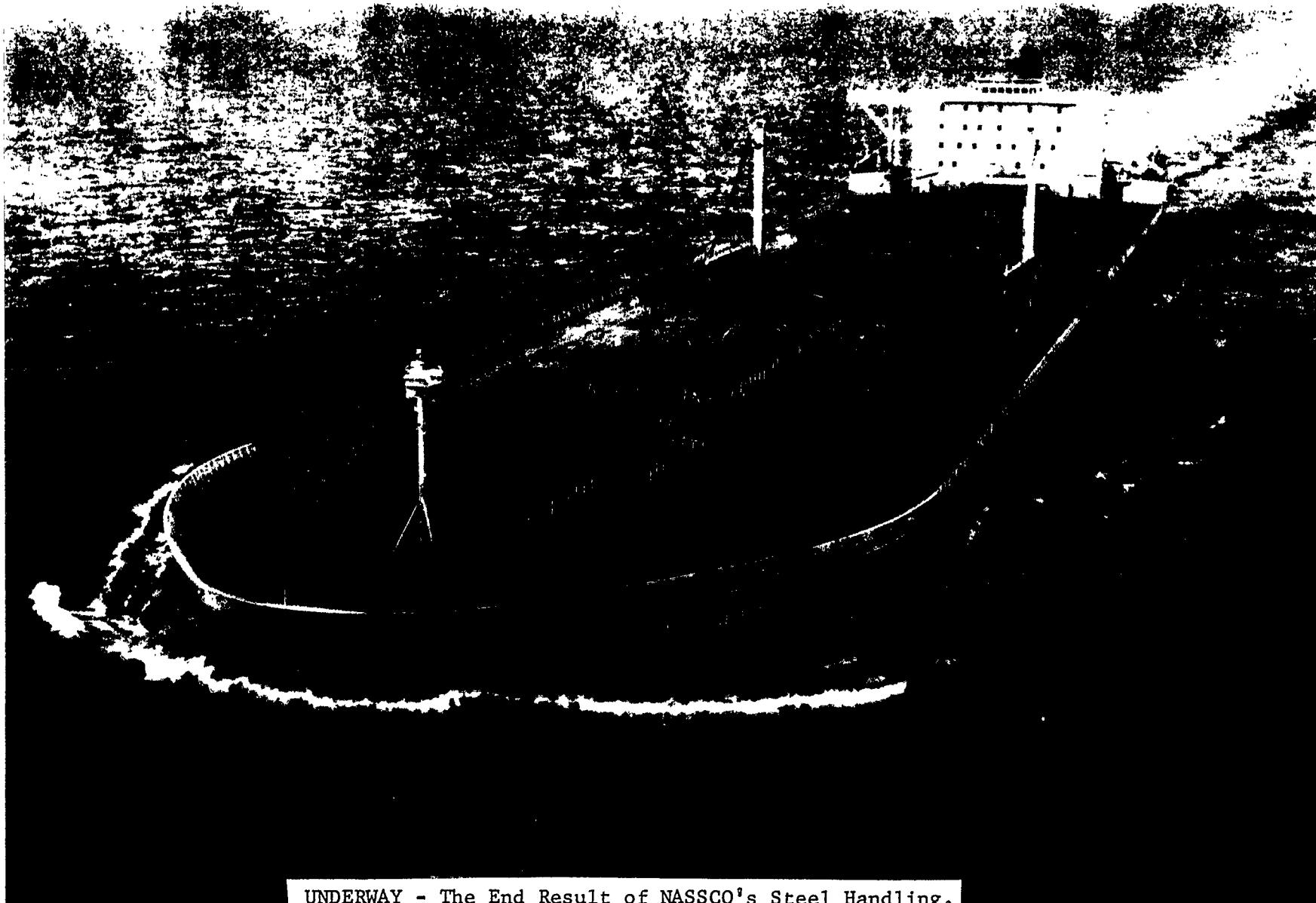
BUILDING DOCK - Approximately Two Weeks After Keel Laying, Dock Dimensions Are 176' by 1,000' Capable of Constructing Ship 170' by 980', 200,000 DWT.

BUILDING DOCK - Approximately Two Weeks Prior to Launch of B.T.  
San Diego, 188,500 DWT San Diego Class Tanker.



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Figure 2



UNDERWAY - The End Result of NASSCO's Steel Handling.

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